The Relationship between Musculoskeletal Strength, Physiological Characteristics and Knee Kinesthesia following Fatiguing Exercise

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INTRODUCTION

- Fatigue has been identified as a risk factor for injury in athletes and trained individuals
- Injuries occur early/late in season
- Fatigue due to poor pre-season conditioning
- Athletes likely experience a combination of peripheral and central fatigue during practice/games
- Peripheral fatigue - changes inside muscle fiber
- Central fatigue - failure to maintain required or expected force due to CNS alterations
- Fatiguing exercise may negatively impact neuromuscular control and proprioception, resulting in:
  - Altered muscle activation patterns and lower extremity mechanics
  - Deficits in joint position sense and threshold to detect passive motion
- Several musculoskeletal and physiological mechanisms may contribute to fatigue onset
  - Individuals with higher levels of strength and fitness may be better able to offset fatigue

EXPERIMENTAL DESIGN AND METHODS, CONT’D

PROTOCOLS
- Visit 1
  - Familiarization session for TTDPM in extension and flexion of the dominant knee (Biodex Multi-Joint System 3 Pro Dynamometer, Shirley, NY) (Figure 1)
  - 20° knee flexion start position, arm speed 0.25°/sec
  - Isokinetic strength of quadriceps and hamstrings (Biodex Multi-Joint System 3 Pro Dynamometer, Shirley, NY)
  - VO2peak and LT
  - Graded treadmill exercise test
    - Inspired/expired gases collected with TrueOne2400 (Parvomedics, Sandy, UT)
    - VO2peak and both pre-fatigue and post-fatigue TTDPM in flexion and extension
- Visit 2
  - Pre- and post-fatigue testing
    - TTDPM
    - Isometric knee strength (Biodex)
    - 7-Station Fatigue Protocol (Figure 2)
      - Station 1: 5-min run at 95% VO2 pace
      - Station 2: 3-min run at 110% VO2 pace
      - Station 4: 2-min of sit-ups (YMCA partial curl-up)
      - Station 5: 3-min of 12-in step-ups
      - Station 6: 3-min run at 110% VO2 pace
      - Station 7: 2-min run at 110% VO2 pace
    - If a subject was not volitionally fatigued at the end of station 7, the station continued, and with each additional minute, the incline of the treadmill was increased by 1%

STATISTICAL ANALYSIS
- Shapiro-Wilk tests and normality plots assessed normality of each variable
- Wilcoxon signed rank tests determined TTDPM and strength differences from pre- to post-fatigue
- Spearman’s Rho correlation coefficients determined relationships between variables of interest

RESULTS

- Significant decreases in isometric hamstring strength and flexion/extension ratio were revealed following fatigue (Table 1)
- No significant correlations were revealed between isokinetic knee strength, flexion/extension strength ratio, VO2peak or LT and changes in TTDPM in flexion or extension (Table 2)
- A significant, low correlation was revealed between flexion/extension strength ratio and pre-fatigue TTDPM in flexion and extension (Table 2)

SUMMARY AND CONCLUSIONS

- Results did not demonstrate a significant relationship between the chosen modifiable musculoskeletal and physiological characteristics and changes in proprioception following fatigue, and this may be due to the overall high fitness level of the subjects
- The significant correlation between VO2peak and TTDPM in extension suggests a linear relationship between individuals with higher aerobic capacity and better proprioception
- Future studies should consider different subject populations, other musculoskeletal strength characteristics, and various modalities of proprioception to determine the most important contributions to proprioceptive changes following fatigue

This work was supported by the Freddie H. Fu, MD Doctoral Research Award